WASHINGTON
SCIENCE TRENDS

HIGHLIGHTS

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Anti-Satellite Research?

Advanced Research Projects Agency (ARPA) has asked the Naval Research Laboratory to conduct hypervelocity capability and impact studies believed to be connected with satellite interception and destruction projects.

Specifically, the Navy will attempt to develop techniques and equipment capable of accelerating two grams of mass to a velocity of 30,000 feet per second or more. Impact effects on "thin targets" as well as semi-infinitely thick targets will be investigated.

Soviet Lubricant Research

A department of the U.S. Government, presumed to be the Central Intelligence Agency, has completed an extensive study of Soviet Bloc technical abstracts in the field of lubricants. Here are the official conclusions:

* Nothing is revealed demonstrating that Soviet developments in this area are ahead of the U.S. No new, novel, or different methods, than known or used in the U.S., for providing lubrication at the extremes of temperatures, or the extremes of equipment usage as they relate to bearing speeds, materials and loads, were found.

* No clear-cut references were found indicating any substantial work on,or usage of, synthetic esters as base stocks. There was indication or work on making or synthesizing materials of this type, but this is nothing new.

* When specific reference was made to lubricants, the implication was that the more conventional petroleum products, from Soviet refinery and crude sources, were used. There was little reference to performance limitations of these products.

* The greatest number of references related to phosphorus chemistry. However, there were no clear-cut references showing that these organo-phosphorus compounds were intended as additives for lubricants. The references indicated the synthesis of a great variety of phosphorus compounds together with new methods of preparation and new reactions.

* A substantial amount of research is indicated in hydrocarbon chemistry and reactions. There are indications that an aggressive and imaginative program is being conducted in hydrocarbon chemistry. This research could lead to new petroleum processes and products, if it is properly developed and coordinated.

SPECIAL REPORT -- MASS TRANSFER COOLING AND AERODYNAMICS RESEARCH

Here is a Special Report from official sources on plans of the National Aeronautics and Space Administration (NASA) to construct and operate an advanced facility at the Ames Research Center, Moffett Field, Calif. for research, development, test and evaluation in the fields of mass transfer cooling and aerodynamics.

Equipment -- The facility will be a combination of vacuum pumping equipment, electrical arc heaters, and high-pressure storage equipment which, in various combinations, will provide the following three pieces of equipment:

* A low-Reynolds-number, near-orbit-mach-number tunnel primarily designed for the purpose of measuring forces and moments on complete configurations operating in the low Reynolds number continuum-flow regime typical of that encountered by orbiting and shallow reentry type vehicles.
* An arc-heated, high-velocity jet primarily designed for the purpose of investigating heating effects encountered in relatively low level (long duration) heat-flux conditions at hypersonic speeds (typical of shallow reentry conditions).
* An arc-heated, high-heat-flux jet primarily designed for the purpose of investigating heat transfer effects in high-level, short duration, heat-flux conditions at low supersonic mach numbers (to investigate conditions typical of steep reentry).

Low-Reynolds-number, near-orbital-mach-number tunnel -- This tunnel will produce a 1-foot diameter usable test stream having a mach number range from 10 to 20 and test section pressures from 0.1 to 0.5 millimeter of mercury (giving a Reynolds number range of 10^4 to 10^6 per foot). Replaceable nozzles for a mach number range of from 10 to 20 will be provided. Model support and balance equipment necessary to permit force and moment measurements on complete configurations or parts thereof are included as part of the proposal.

Arc-heated, high-velocity jet -- This jet will produce a test stream of approximately 1-foot to 2-foot diameter at velocities from about 20,000 to 26,000 feet per second. The air supply for this tunnel will be stored at pressures of the order of 3,000 pounds per square inch before passage through the heater. Sufficient capacity for 30 minutes' running time will be provided. The air will be heated by high current-density electric arc heaters, followed by a stagnation chamber with cooled walls, and cooled hypersonic nozzle and diffuser. Several removable nozzles will be supplied to provide streams with different velocities. One stagnation chamber will be suitably equipped to program with time the enthalpy and pressure levels, and a corresponding nozzle will be equipped to simultaneously program the model position along the model axis, so that the model experiences the same time history of both chemical state and heat flux as would exist during reentry.

Arc-heated, high-heat-flux jet -- This jet will produce a test stream of approximately 3-inch diameter with air heated to an energy level that will enable reproduction of heat-flux rates approximating those encountered in a steep atmospheric entry but at reduced mach number. The tunnel will use the same storage air and heater as used in the arc-heated, high-velocity jet. Running time will be primarily a function of electrode and nozzle cooling requirements and will be limited to as low as 10 seconds at the higher pressure, temperature and heat-flux rate conditions.

RESEARCH PLANS

Aerodynamic research -- The aerodynamic research to be conducted will be the investigation of low Reynolds number, hypersonic aerodynamic phenomena which are encountered during shallow entries into the atmosphere. Previous experiments at low Reynolds numbers have been confined to relatively low supersonic Mach numbers. Near conditions of peak heating during a shallow entry (e.g., satellite vehicle with or without lift), the Mach number is about 20 and the corresponding Reynolds numbers are the order of 10^3 to 10^2. These relatively low Reynolds numbers are within the continuum-flow regime but when combined with the hypersonic Mach numbers, produce unusually thick boundary layers which modify the flow field and heat transfer. Because essentially no investigations have yet been conducted in this domain where low Reynolds numbers are combined with hypersonic Mach numbers, a large gap exists in present knowledge about the forces, moments, and stability characteristics, as well as the heat transfer to shallow entry vehicles.

Heat transfer and mass transfer research -- A sizable portion of the thermodynamic states encountered during both shallow entries and steep entries (ballistic vehicles or return interplanetary instrument carriers) can be duplicated. When reproducing the relatively high heat fluxes corresponding to steep entries the facility would be operated only for the relatively short duration of steep entries (10 seconds, approximately), whereas for the much lower heat fluxes corresponding to shallow entries the facility would be operated for durations the order of 5 to 30 minutes.

Much work is in progress on mass transfer cooling systems inasmuch as they offer the advantages of light weight combined with high effectiveness and inherent simplicity. In order that laboratory tests of such systems be applicable to reentry conditions, it is necessary to duplicate the enthalpy level, the heating rate, the chemical state of the system (by chemical state is meant the homogeneous gas reactions, the heterogeneous reactions, and the solid-liquid-gas phase transformations). An arc-heated facility duplicates the enthalpy level by employing high reservoir temperatures, and reproduces the convective heating rate by operating at relatively high reservoir pressures. The chemical state is duplicated by operating on the same time scale as exists in flight.

Facilities which reproduce the same enthalpy conditions as are encountered during reentry are of three general types: Those employing hypervelocity guns, those employing shock tubes, and those employing electric arc-heated jets. The first two types duplicate the enthalpy level, but they do so in a test time the order of a very small fraction of a second. The reentry times are much larger, however, ranging from about 15 seconds for steep entries of ballistic and return instrument carriers to about 30 minutes for shallow entries of lifting vehicles. In order to duplicate the chemical state of a mass transfer cooling system (such as an ablation cooling system) wherein the surface material changes phase and then undergoes further chemical reaction with the air, or a radiation cooling system wherein the surface mass undergoes relatively slow oxidation, the testing time must be at least as long as the time required for the various phase transformations and for the complex chemical reactions to take place. Of three types of facility which produce high enthalpies, the arc-heated jet is the only one certain to provide sufficient time for reproducing these phase transformations and chemical reactions. The relatively long time for observation in the arc-heated jet also makes it possible to measure numerous details about the loss of surface material which could not be measured in facilities that operate for only a fraction of a second.

Research Checklist

( ) New Radiation Monitor: A lightweight, battery-powered radiation monitor devised by the U.S. Bureau of Mines is said to offer promise for civilian defense and industrial applications as well as the tracing of radioisotope-bearing water in underground oil reservoirs. The unit reportedly can be mass-produced for $500 to $600 compared with a retail price of at least $3,000 for commercial models that are not portable.

(Further information, including details of construction, available from Bureau of Mines, Petroleum Experiment Station, Bartlesville, Oklahoma)

( ) Precision Wavelength Measurements: Research at the Los Alamos Scientific Laboratory has led to development of new photoelectric comparator for wavelength and intensity measurements of spectra. The device is said to be of more rugged construction than previous instruments and to provide improved density readings and a larger light intensity on the photomultiplier tube. In addition to spectra, any transparent or opaque subject could be measured.

(Report available. 29 pages. $1. Write OTS, U.S. Department of Commerce, Washington 25, D.C. for Pub. No. LA-2280)

( ) Rocket Motor Tests: Navy researchers report tentative findings indicate "good correlation" of results obtained in static firing tests of solid propellant rocket motors employing a special "coffin" assembly. Studies are aimed at developing meaningful data on vibration and shock during restrained firings in advance of actual flight. Additional tests are planned to validate further the "coffin" testing technique.

(R&D by Mechanics Division, Structures Branch, U.S. Naval Research Laboratory, Washington 25, D.C.)

( ) Meteor Scatter Communications: Research at the Engineering Experiment Station, Knoxville, Tenn., now declassified, has been concerned with a mechanical analog for predicting the optimum directions for pointing the antennas used in meteor scatter communication, subject to the assumption that there is some ecliptic concentration of meteor radiants. A new antenna mount was devised to ensure that both the transmitting and receiving antennas have the optimum polarization for radio transmission via radio waves scattered from a small region of ionization.

(Report available. 16 pages. Microfilm, $2.40. Photocopy, $3.30. Order PB 135 889 from Photoduplication Service, Library of Congress, Washington 25, D.C.)

( ) Radio-Frequency Energy: An Agriculture Department study indicates that control of stored-grain insects is possible with heat from radio-frequency electric fields. Experimental equipment quickly killed all of several species of insects in stored wheat but application of this method on a large scale will depend upon further equipment development.

(Further Details available. Free. Write Room 403-A, U.S. Department of Agriculture, Washington 25, D.C. for Release 1547-59)

( ) Saline Water Conversion: An electrodialysis process has been selected for a demonstration plant designed to convert brackish water to fresh water at an anticipated rate of at least 250,000 gallons daily. The process uses a cell consisting of a set of electrodes between which are a large number of closely-spaced membranes made of materials which will permit only positive or negative ions to pass. The electric field in the cell removes the salts or ions from the water.

(Some details available. Free. Write Information Service, Department of the Interior, Washington 25, D.C. for P.N. 57051-59)

( ) Metal Fracture Strength: Research at Harvard University has led to a new testing procedure in which high explosives are used to determine the fracture strengths of such extremely ductile metals as high purity aluminum. A steep-fronted tension wave causes fracture when it exceeds the strength of the plate under test. The shape of the wave is observed with pellets and high-speed photography techniques.

( ) Millimicrosecond Discriminator: Research sponsored by the Atomic Energy Commission at the Lawrence Radiation Laboratory, Berkeley, Calif., has led to development of a discriminator circuit for use with millimicrosecond counting equipment. A discriminator device is a necessary element in most electronic counting arrangements in order to determine the voltage level at which pulses are fed to a recording device.

(Report available. 12 pages. 50 cents. Write OTS, U.S. Department of Commerce, Washington 25, D.C. for UCRL-8569)

( ) Controlled Fusion Research: Research in connection with the thermonuclear power programs includes a study of the behavior of particles comprising a plasma as predicted by single particle motions. Equations show that in the presence of nonuniform magnetic fields, and/or other nonmagnetic force fields the particles not only move along the field lines but also drift across.

(Studies by Analysis and Theory Branch, Radiation Division, U.S. Naval Research Laboratory, Washington 25, D.C.)

( ) Metal-Ceramic Laminates: Studies at Alfred University for the U.S. Air Force indicate that metal-ceramic laminates can be fabricated when the thermal expansion of the ceramic is equal to or slightly less than that of the metal. Brazing and hot-pressing techniques were used and a comparative apparatus for measuring thermal conductivity was constructed and found accurate to plus or minus two percent in the temperature range 100 to 1000°C.

(Report available. 78 pages. $2. Write OTS, U.S. Department of Commerce, Washington 25, D.C. for PB 151 664)

( ) Government Research: "Small" business firms interested in obtaining government research and development prime or sub contracts are invited to register their qualifications with the Small Business Administration, Washington 25, D.C. Forms for this purpose (Form 449) are available from SBA in Washington or at SBA Regional Offices. The information should be submitted by July 17 for inclusion in an R&D directory issued to Government Purchasing Offices and prime contractors.

Publications Checklist

( ) Nuclear Explosions in Space, a staff report on Project Argus including some information on military and scientific significance of the experiments. 6 pages. Free. (Write Committee on Science and Astronautics, New House Office Building, The Capitol, Washington 25, D.C.)

( ) HEW Appropriations, statements, testimony and exhibits relating to the varied programs of the Department of Health, Education and Welfare including the National Institutes of Health, Office of Education and other related organizations. 1346 pages. Free. (Write Committee on Appropriations, New Senate Office Building, The Capitol, Washington 25, D.C. for Hearings - H.R. 6769)

( ) Atomic Energy Industry, statements, testimony and exhibits by Government and industrial witnesses on the development, growth and state of the atomic energy industry. A valuable guide to plans and programs as of February, 1959. Just published. 629 pages. Free. (Write Joint Committee on Atomic Energy, F-88, The Capitol, Washington 25, D.C. for Section 202 Hearings)

( ) Computers, a catalog of all reports available to industry and the public on digital, analog, photographic, mathematical, navigational and other types of computers for the period 1937-1958. Free (Write OTS, U.S. Department of Commerce, Washington 25, D.C. for CTR-371)

( ) Missile and Space Programs, a brief report based on hearings with administrative, military and technical officials in industry and Government Agencies. 10 pages. Free. (Write Committee on Science and Astronautics, New House Office Building, The Capitol, Washington 25, D.C. for Report No. 13)

( ) Fiber Glass and Glass Laminates, a catalog listing all reports of research available to industry and the public in the fields of fiber glass and glass laminates. Free. Write OTS, U.S. Department of Commerce, Washington 25, D.C. for CTR 292)

( ) Solar Absorption Lines, a paper on the doppler widths of solar absorption lines, originally appearing in the Smithsonian Contributions to Astrophysics. 7 pages. 20 cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D.C. for Pub. No. SI 1.12/2:3/5)

( ) Transistors, a newly-published Army manual on the basic theory and application of transistors. Covers fundamental theory, data on transistor amplifier fundamentals; parameters equivalent circuits; bias stabilization and similar material. Designed for the electronic technician who has a detailed knowledge of the theory and application of electron tubes. 263 pages. $1.25. (Write Superintendent of Documents, Government Printing Office, Washington 25, D.C. for Pub. No. D 101.11:11-690)

( ) Radioactive Waste Disposal, a report by a special panel appointed by the National academy of Sciences expressing the opinion that certain coastal waters can be used for disposal of low-level radioactive wastes. 37 pages. $1.00. (Write Publications Office, National Academy of Sciences, 2101 Constitution Avenue, Washington 25, D.C. for Publication 655)